A low energy threshold $CdWO_4$ scintillating bolometer for g_A measurement

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Poster #383

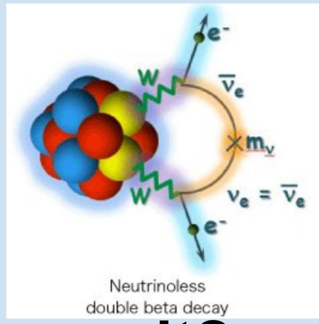
ABSTRACT: neutrinoless double beta decay 0νββ is expected to be a rare nuclear transition. One of the main elements to design a 0νββ experiment is the prediction of the decay half-life, which strongly depends on the axial-vector coupling g_A. A quenched value of g_A is a source of spectral distortion in highly-suppressed single beta decay spectra. In this poster, we present the results from a test of a $CdWO_4$ scintillating bolometer installed in the underground laboratory of Canfranc in the CROSS facility. The aim of this test is to reconstruct the spectrum of the beta decay of ^{113}Cd naturally present in the crystal down to an energy threshold of 8 keV. A trigger efficiency analysis was performed to have a reliable reconstruction of the spectrum. The final goal is to use the spectral shape method to derive the effective value of g_A from the precise measurement of the beta decay spectrum.

Neutrinoless double beta decay and axial-vector coupling g_A in a nutshell

0νββ is a very rare nuclear transition, not yet observed. Most stringent limits on the half-life: **$T_{1/2} > 10^{24} - 10^{26}$ years**

A key element to build a 0νββ experiment is the prediction on the half-life $T_{1/2}$

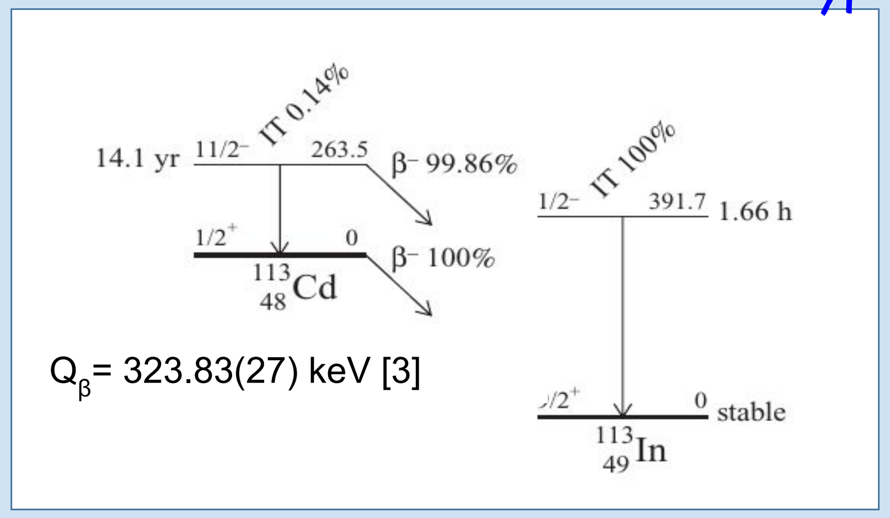
$$(T^{0\nu}_{1/2})^{-1} = G^{0\nu} \boxed{g_A^4} |M^{0\nu}|^2 < m_{\beta\beta} >^2$$



Axial-vector coupling

g_A can be quenched, why and how to measure it?

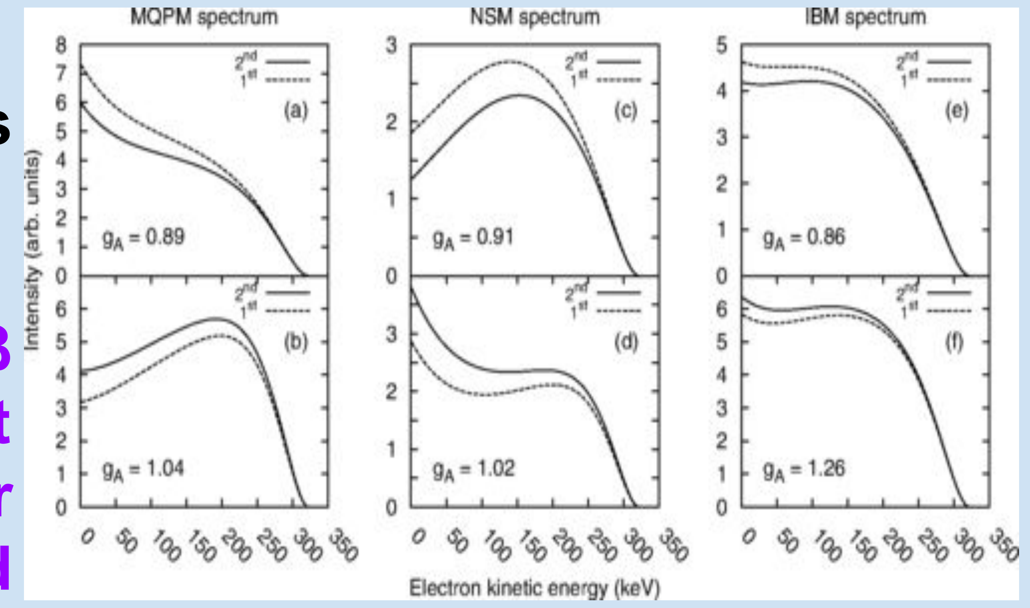
- g_A appears in the weak interactions
- $g_A^{free} = 1.25$
- Sources of quenching of g_A: non-nucleonic degrees of freedom, nuclear many body effect [1]



In the spectral shape of high-forbidden β decays using the Spectral Shape Method (SSM) [2]

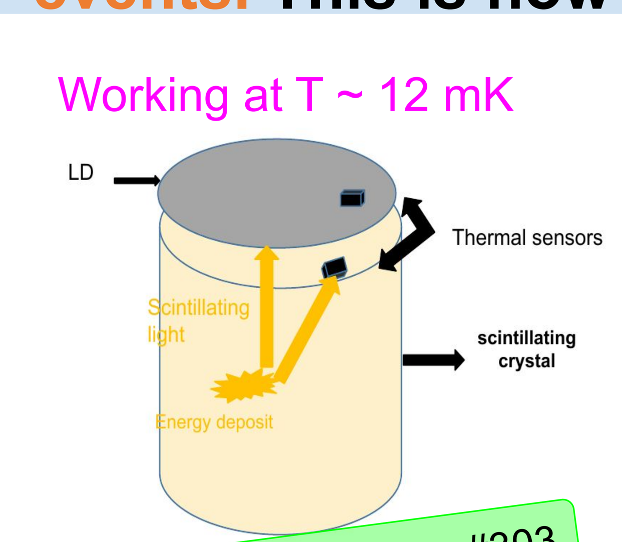
The SSM: the β-spectral shape at low enegies is sensitive to g_A[2].

The four-fold forbidden β decay in ^{113}Cd decay is not masked by other lower ordered decays or allowed beta decays



The bolometric technique and $CdWO_4$ crystal

A bolometer is a low temperature detector. It is composed by an **absorber** and a **thermal sensor. Double readout light and heat = full separation γ(β)/α and rejection of non physical events. This is how works a scintillating bolometer !**



Performances

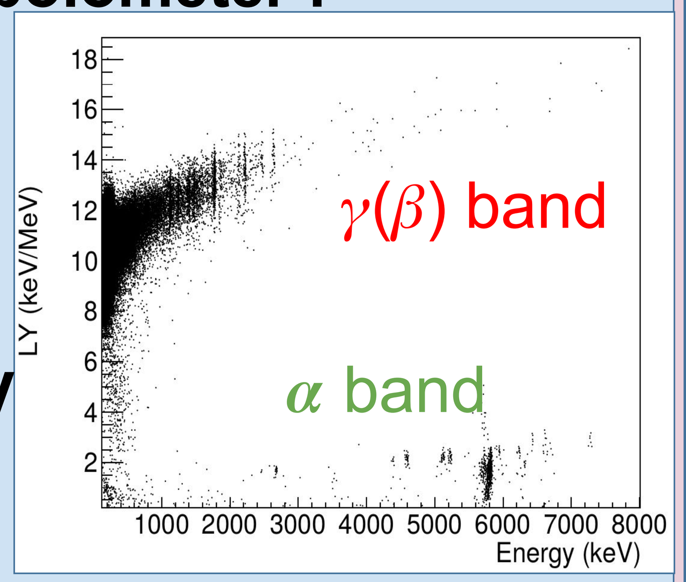
Baseline noise

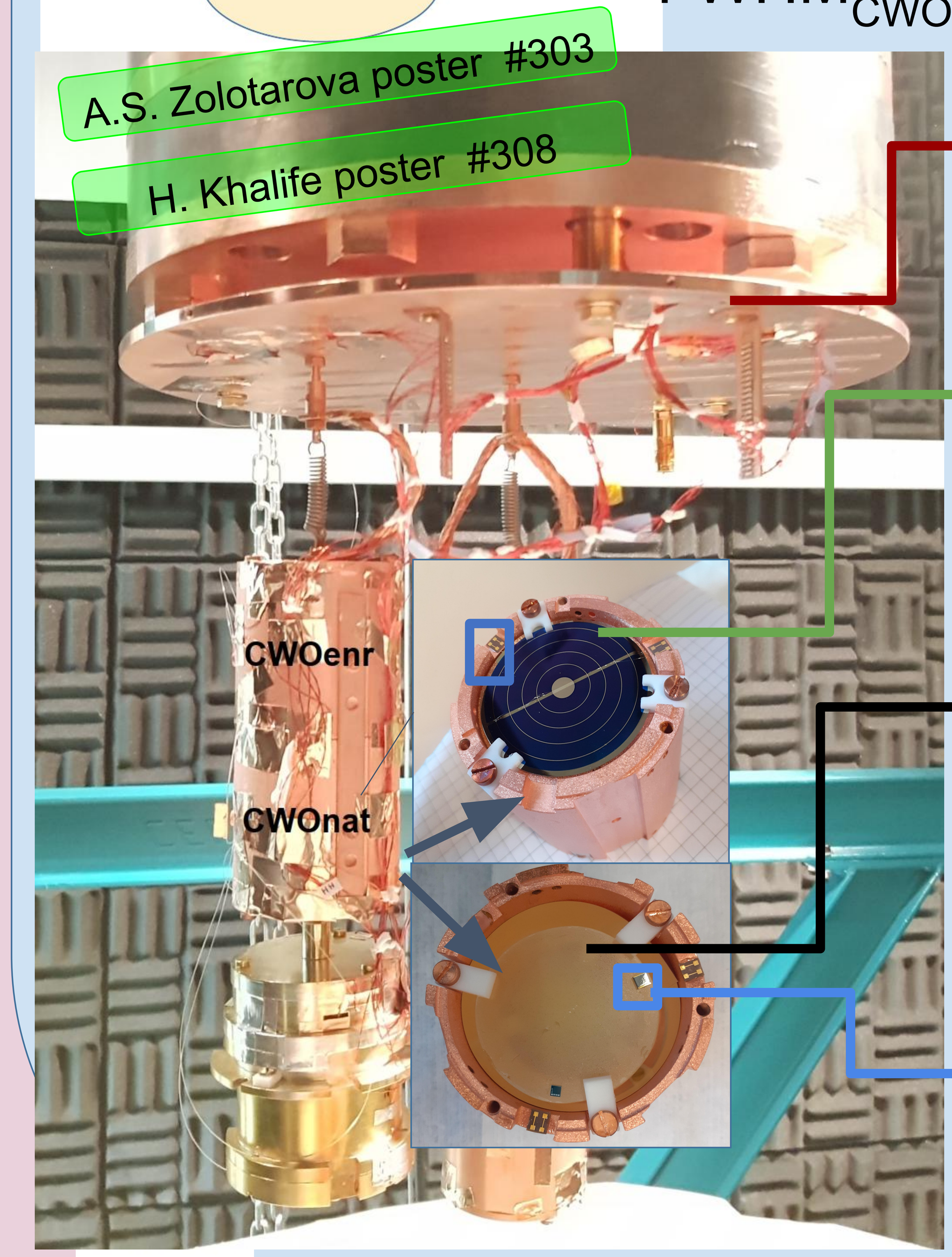
$FWHM_{CWOnat}$=3.2 keV

$FWHM_{NG\text{-}Luke\ LD}$=30 eV

Resolution at 2.6 MeV

$FWHM_{CWOnat}$=8.9 keV





The CROSS cryostat at the underground laboratory of Canfranc

Neganov-Luke light detector (NG-Luke LD) made of Ge

$CdWO_4$ (CWOnat) scintillating crystal (433 g). I.A. of ^{113}Cd is 12.22(4)% [4]. Previously measured in [4] as a scintillator.

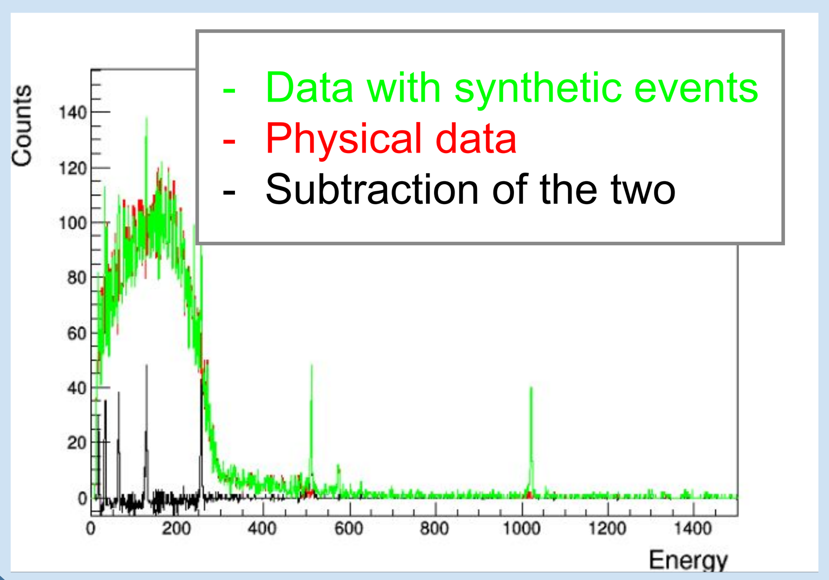
$T_{1/2}$ = (8.04 ± 0.05)×10^{15} yr [4]

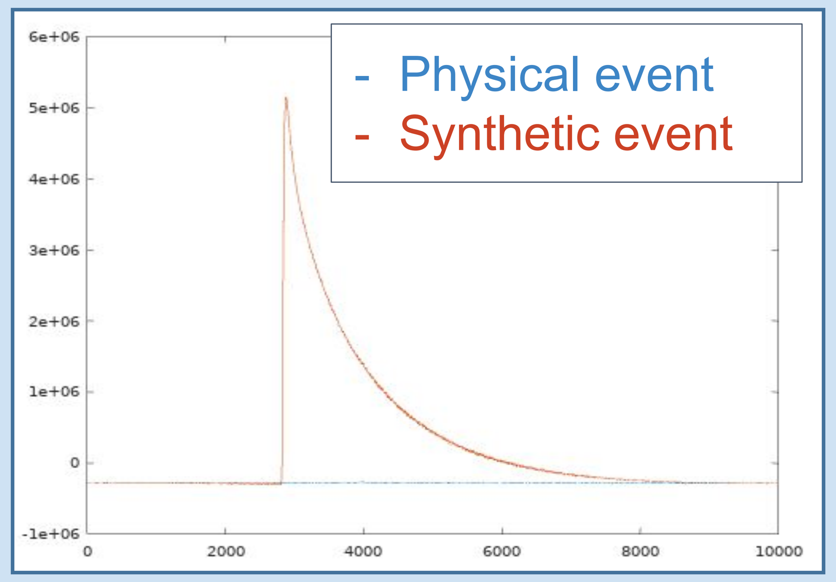
Thermal sensor (NTD) to register the particles energy deposit

Trigger efficiency analysis results and discussions

How to do we measure our trigger efficiency ?

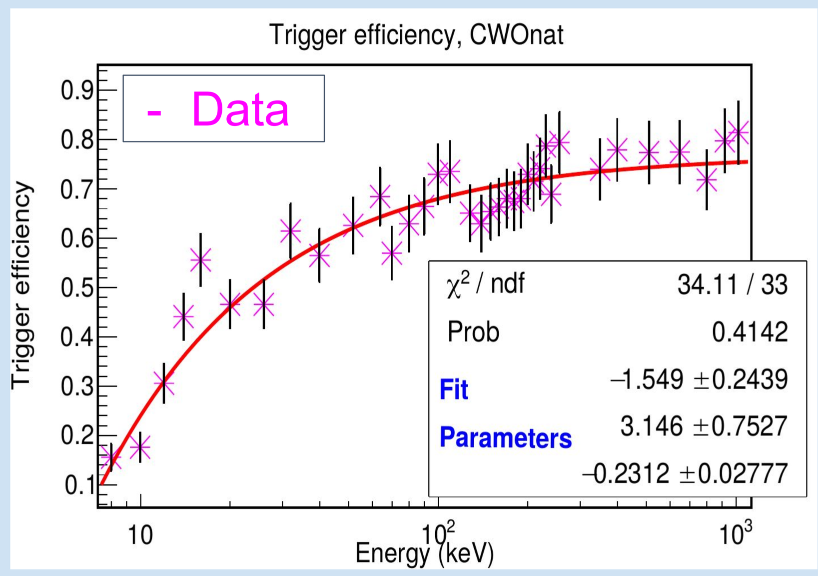
1. *Inject synthetic event,* based on an average pulse of physical event scaled to a given energy, in the stream data
2. Process and analyse the data with the synthetic pulses as physical data
3. Subtract the data with synthetic event from the physical data
4. Compute the integral of each peak that corresponds to the injected events
5. Draw the trigger efficiency profile: *RESULTS !*

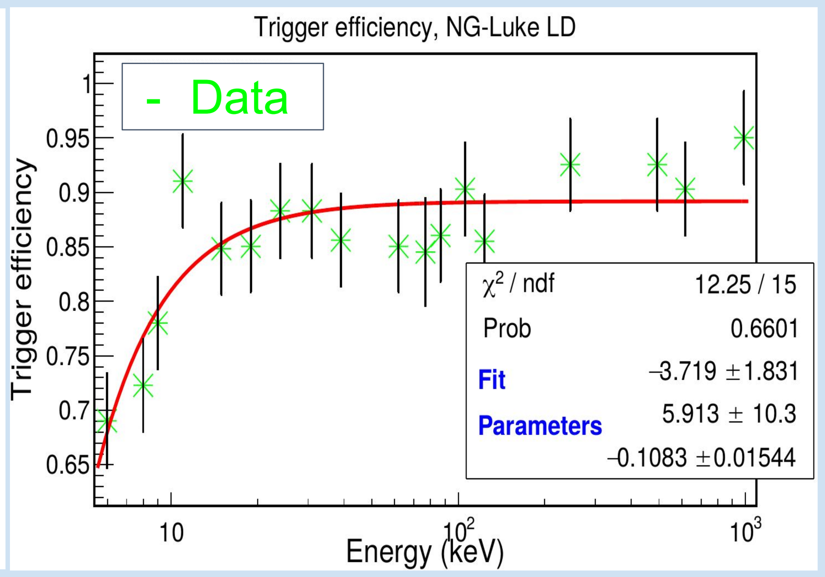




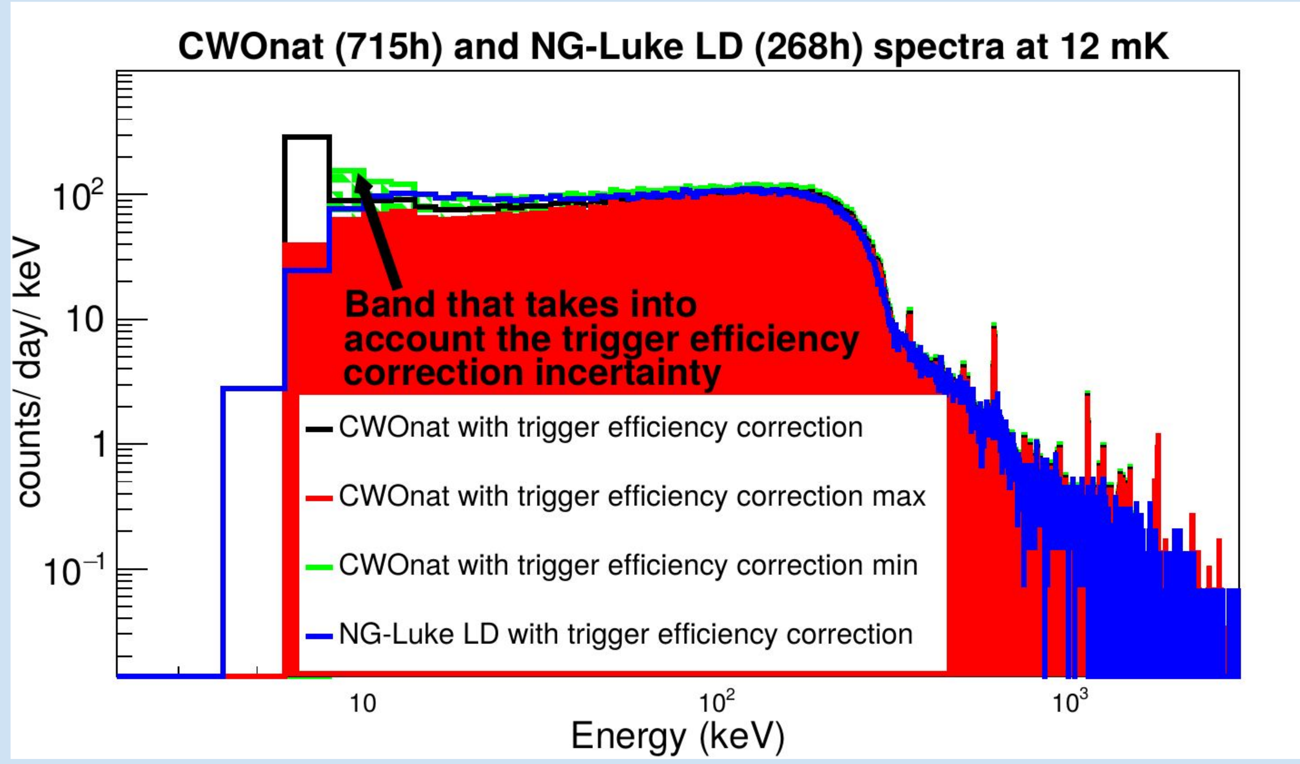
The Results

Trigger efficiency profiles and fits





Trigger efficiency correction applied to background data



Conclusions and outlook

- Promising results for gA studies were achieved with both the heat and the light channel of $CdWO_4$
- A background model is under study and construction
- The SSM will be applied to the trigger efficiency corrected spectra to extract the effective value of g_A

References

[1] A. Bohr and B.R. Mottelson, Phys. Lett. B 100, 10 (1981)
[2] M. Haaranen, P. C. Srivastava, and J. Suhonen, Phys. Rev. C 93, 034308
[3] M. Wang et al., Chinese Physics C 41 (2017) 030003
[4] P. Belli et al., Phys. Rev. C 76 (2007) 064603

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